

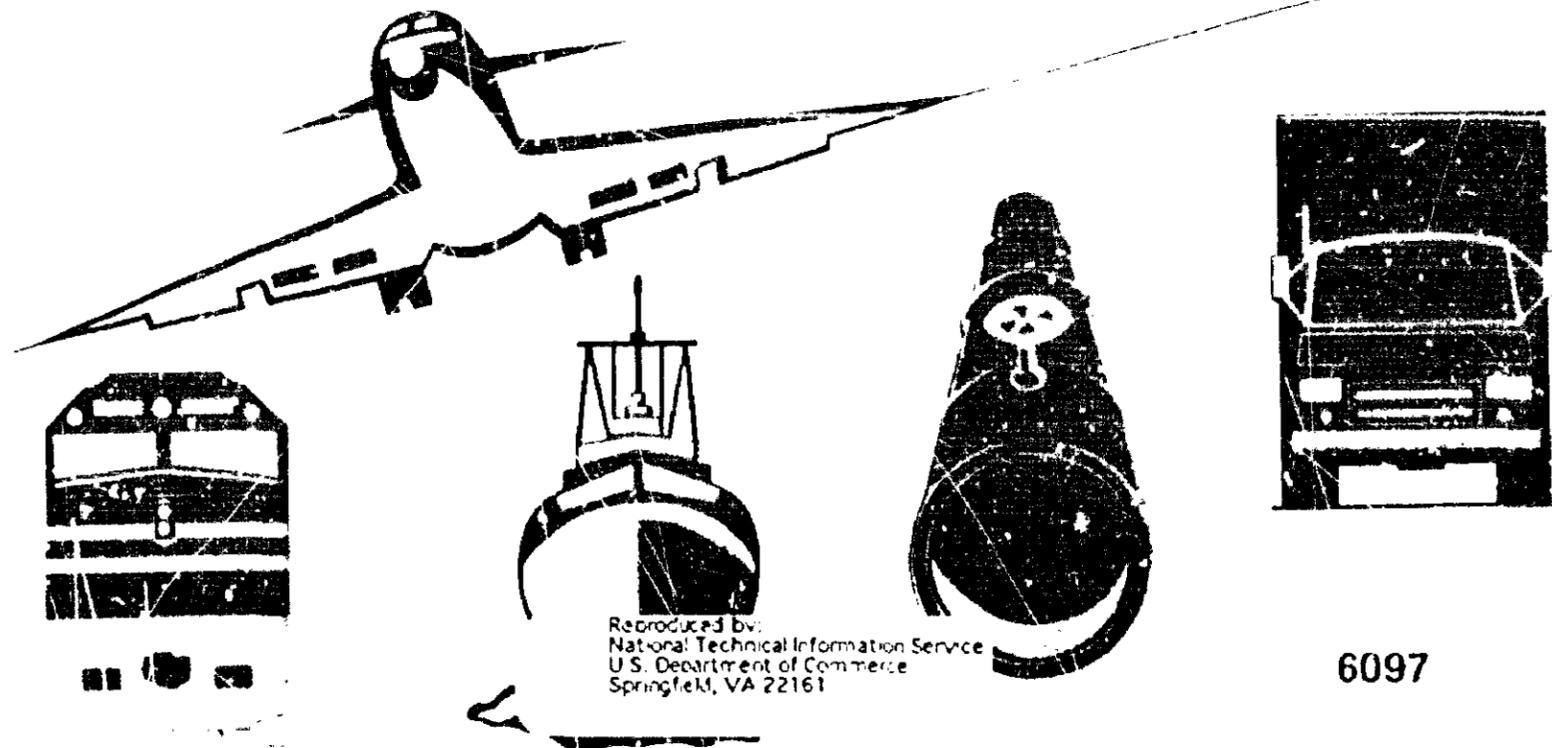
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# NATIONAL TRANSPORTATION SAFETY BOARD

WASHINGTON, D.C. 20594

## AIRCRAFT ACCIDENT REPORT

MIDAIR COLLISION  
MITSUBISHI MU-2B-60, N74FB, AND PIPER PA-32-301, N82419  
GREENWOOD MUNICIPAL AIRPORT  
GREENWOOD, INDIANA  
SEPTEMBER 11, 1992



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SAFETY BOARD**

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**SEPTEMBER 11, 1992**

**Adopted: September 13, 1993**

**Notation 6097**

**Abstract:** This report explains the midair collision of an MU-2 aircraft with a PA-32 aircraft about 2 miles northeast of the Greenwood Municipal Airport, Greenwood, Indiana, on September 11, 1992. Safety issues in the report focused on the deficiencies in the see-and-avoid concept as a primary means of collision avoidance, and the failure of pilots to fully utilize the air traffic control system by obtaining instrument flight rules clearances before takeoff. Recommendations concerning these issues were made to the Federal Aviation Administration, the National Business Aircraft Association, the National Association of Flight Instructors, the Experimental Aircraft Association, and the Aircraft Owners and Pilots Association.

## CONTENTS

<b>EXECUTIVE SUMMARY.....</b>	<b>v</b>
<b>1. FACTUAL INFORMATION</b>	
1.1 History of Flight .....	1
1.2 Injuries to Persons .....	4
1.3 Damage to Aircraft.....	4
1.4 Other Damage .....	4
1.5 Personnel Information .....	6
1.5.1 The Pilot of the PA-32.....	6
1.5.2 The Pilot of the MU-2 .....	7
1.5.3 Air Traffic Controller .....	8
1.6 Aircraft Information.....	8
1.7 Meteorological Information .....	9
1.8 Aids to Navigation .....	10
1.9 Communications.....	10
1.10 Aerodrome Information .....	10
1.11 Flight Recorders .....	12
1.12 Wreckage and Impact Information.....	12
1.12.1 The MU-2 .....	12
1.12.2 The Piper PA-32.....	13
1.13 Medical and Pathological Information .....	14
1.14 Fire .....	15
1.15 Survival Aspects.....	15
1.16 Tests and Research.....	16
1.16.1 Indianapolis TRACON.....	16
1.16.2 Airplane Performance Calculations.....	18
1.16.3 Cockpit Visibility Study .....	19
1.17 Additional Information .....	22
1.17.1 Survivor Interviews .....	22
1.17.1.1 Arrival and Departure Procedures at Greenwood Airport.....	23
1.17.2 See and Avoid .....	24
1.17.3 ATC Procedures .....	26
<b>2. ANALYSIS</b>	
2.1 General .....	30
2.2 Cockpit Visibility Study .....	30

2.3	Analysis of the Collision Geometry .....	32
2.4	Airport Traffic Pattern Areas - Uncontrolled Airports.....	37
2.5	In-flight IFR Clearance Procedures.....	39
2.6	Corporate Aircraft Workload.....	40
2.7	Operation Near an Airport.....	41
2.8	The See-and-Avoid Concept.....	42
2.9	Human Performance Analysis.....	43
3.	<b>CONCLUSIONS</b>	
3.1	Findings .....	47
3.2	Probable Cause .....	48
4.	<b>RECOMMENDATIONS</b> .....	49
5.	<b>APPENDIXES</b>	
	Appendix A--Investigation and Hearing.....	51
	Appendix B--Personnel Information .....	52
	Appendix C--Cockpit Field of Vision Plots.....	54
	Appendix D--FAA Advisory Circular 90-48C Pilots' Role in Collision Avoidance .....	57
	Appendix E--Air Traffic Control Transcript.....	65

## EXECUTIVE SUMMARY

On September 11, 1992, about 1457 central daylight time, a Mitsubishi MU-2B-60 (MU-2), N74FB, and a Piper PA-32-301 Saratoga (PA-32), N82419, collided at 2,100 feet mean sea level, approximately 2 miles northeast of the Greenwood Municipal Airport, Greenwood, Indiana. The PA-32 was descending from 2,500 feet en route to Greenwood Airport in accordance with visual flight rules. The MU-2, also operating under visual flight rules, was climbing out of the Greenwood Municipal Airport en route to Columbus, Ohio. The pilots of both airplanes and the four passengers aboard the MU-2 were fatally injured. The two other occupants of the PA-32 were seriously injured. Both airplanes were destroyed. The accident occurred in daylight visual meteorological conditions.

Prior to the collision, the PA-32 had been receiving air traffic control radar services from the Indianapolis Departure East/Satellite Controller. When the airplane was 3 miles north of the Greenwood Airport, radar services were terminated. Approximately 44 seconds later, the pilot of the MU-2 reported to the radar controller that he was "off Greenwood" in anticipation of receiving an instrument flight rules clearance. The radar controller issued a discrete beacon code, but the flight had not been identified on radar at the time of the collision.

The National Transportation Safety Board determines that the probable cause of the accident was the inherent limitations of the see-and-avoid concept of separation of aircraft operating under visual flight rules that precluded the pilots of the MU-2 and the PA-32 from recognizing a collision hazard and taking actions to avoid the midair collision. Contributing to the cause of the accident was the failure of the MU-2 pilot to use all of the air traffic control services available by not activating his instrument flight rules flight plan before takeoff. Also contributing to the cause of the accident was the failure of both pilots to follow recommended traffic pattern procedures, as recommended in the Airman's Information Manual, for airport arrivals and departures.

The major safety issues addressed by the report are the continuing problem of deficiencies in the see-and-avoid concept, as a primary means of collision avoidance, and the failure of pilots to fully utilize the air traffic control system by obtaining instrument flight rules clearances prior to becoming airborne, especially when operating in or near high density traffic areas.

As a result of this accident and others, safety recommendations addressing these issues were made to the Federal Aviation Administration, the National Business Aircraft Association, the National Association of Flight Instructors, the Experimental Aircraft Association, and the Aircraft Owners and Pilots Association.

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I. FACTUAL INFORMATION

1.1 History of Flight

On September 11, 1992, about 1457 central daylight time, a Mitsubishi MU-2B-60 (MU-2), N74FB, and a Piper PA-32-301 Saratoga, (PA-32), N82419, collided at 2,100 feet mean sea level (msl)<sup>1</sup> in southern Marion County, Indiana. The collision occurred approximately 2 miles northeast of the Greenwood Municipal Airport, Greenwood, Indiana. The PA-32 was descending from 2,500 feet en route to Greenwood Airport in accordance with visual flight rules (VFR). The MU-2, also operating under VFR, was climbing out of the Greenwood Municipal Airport en route to Columbus, Ohio. The pilots of both airplanes and the four passengers aboard the MU-2 were fatally injured. The two other occupants of the PA-32 were seriously injured. Both airplanes were destroyed. The accident occurred in daylight visual meteorological conditions (VMC).

About 1245 central daylight time,<sup>2</sup> the PA-32, owned by Control Systems Engineering Inc., departed Eagle Creek Airport, which is located 7 miles west of Indianapolis, Indiana, for a landing at Greenwood Municipal Airport, Greenwood, Indiana, with an en route stop at Terry Airport, located about 14 miles northwest of Indianapolis, Indiana. On board the airplane was the pilot, a pilot-passenger, and the pilot's daughter. The investigation revealed that the purpose of the flight was to talk to the mechanic at Terry Airport, take aerial photos of the pilot's new office building and a remote job site, and provide flying practice for one

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<sup>1</sup>All altitudes are in msl, unless otherwise indicated.

<sup>2</sup>All times herein are Central Daylight Time (CDT), based on a 24-hour clock, unless otherwise

or both of the qualified pilots on board. The new office building was located about 1 mile east of the collision. The pilot had departed under VFR and had not filed a flight plan, which was not required. The flight was operated under Title 14 Code of Federal Regulations (CFR) Part 91.

The airplane was based at Eagle Creek Airport. According to the manager of the flight school to which the airplane was leased, the pilot flew 10 to 12 times a year. He and the pilot-passenger, who usually flew with him, had arrived at the airport about 1230 on the day of the accident. The pilot's daughter then arrived, and the three of them departed shortly thereafter.

According to a mechanic at Terry Airport, the PA-32 landed about 1330. The pilot toured the facility, asked him about an annual inspection that had been performed there on the airplane, and about possible future work. The mechanic stated that he had never met the pilot before but that he observed him to be in good health and in good spirits.

At 1445:17, the pilot of the PA-32 advised the Indianapolis Departure West/Satellite (DRW/Satellite) controller that he had departed Terry Airport and would land at Greenwood Airport.<sup>3</sup> The controller issued the airplane a discreet beacon code, radar identified the airplane, and instructed the pilot to climb and maintain 2,500 feet. At 1451:47, the controller transferred control of the airplane to the Indianapolis Departure East/Satellite (DRE/Satellite) controller. At 1451:58, the pilot of the PA-32 transmitted to the controller, "Indy Approach, eight two four one nine with you at two point five [2,500 feet] going to Greenwood [Airport]." Seven seconds later the DRE/Satellite controller replied, "Cherokee four one nine roger, maintain, VFR, I'll have on course for you in about five miles." This transmission was acknowledged by the pilot. Approximately 2 minutes later the controller advised, "...you may proceed on course to Greenwood, advise the airport in sight." This transmission was acknowledged by the pilot. At 1455:51, the controller stated, "Cessna four, Cherokee four one nine the airport twelve to one o'clock there and three miles." The pilot replied, "four one nine we have the airport." At 1455:57, the controller stated, "November four one nine, roger, surface winds at indianapolis [Airport] zero two zero at eight, squawk VFR, radar service terminated, frequency change approved." At 1456:03, the pilot replied, "ah four one nine, thank you very much." There were no further communications with the pilot of the PA-32.

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<sup>3</sup>The direct route of flight from Terry Airport to Greenwood Airport put the airplane inside the airport radar service area (ARSA) which required the pilot to be in contact with air traffic control (ATC).

On the morning of September 11, 1992, N74FB, a Mitsubishi MU-2B-60 (MU-2), departed from Huntingburg Airport, Huntingburg, Indiana, en route to Greenwood Municipal Airport. The airplane was owned by and registered to Solar Sources Inc., a coal mining company with offices in Indianapolis, Indiana, and was based in Huntingburg, Indiana. It arrived at the Greenwood Municipal Airport about 1400, where the pilot was observed about 1430 waiting in the lounge area of the local fixed base operator (FBO). Four passengers arrived shortly after 1430 and socialized for several minutes. One was observed using the telephone in the FBO's lounge for about 3 minutes. The pilot and the four passengers then walked out of the lounge area to board the MU-2. The airplane taxied out to the takeoff end of runway 36, and departed shortly thereafter. The pilot of the MU-2 had filed two instrument flight rules (IFR) flight plans with the Terre Haute Flight Service Station (FSS), Terre Haute, Indiana, at 1208. One was for the flight from Huntingburg, Indiana, to Greenwood, Indiana, with a departure time of 1300 and an arrival time of 1330. The other was for the flight from Greenwood, Indiana, to Columbus, Ohio, with a departure time of 1400 and an arrival time of 1445. The flight was operated under Title 14 CFR Part 91.

At 1456:41, the pilot of N74FB contacted the DRE/Satellite controller and stated, "Indy Approach, Mitsubishi seven four Foxtrot Bravo over." The DRE/Satellite controller replied, "Mitsubishi seven four Fox Bravo, Indy." Two seconds later, the pilot of N74FB transmitted, "Roger, I'm off the ground Greenwood [Airport] standing by for [IFR] clearance to Columbus [Airport]." At 1456:51, the DRE/Satellite controller stated, "Seven four Fox Bravo, roger, squawk four five six four and ident. Maintain, at or below five thousand." There were no further communications with the pilot of the MU-2.

Witnesses told Safety Board investigators that there was little traffic landing or departing Greenwood Airport on the day of the accident, which was typical for that airport. They also stated that the MU-2 was the only high performance airplane that regularly operated out of Greenwood Airport. Witnesses who observed the airplanes prior to the collision said that the PA-32 was southbound, while the MU-2 was climbing and turning toward the east. They stated that the PA-32 struck the MU-2's fuselage in the area of the empennage.

The airplanes collided about 1457 at an altitude of 2,100 feet (see figure 3 for plots of the radar data for both airplanes). The pilot-passenger on the PA-32 took control of the airplane and was able to make a controlled landing before the airplane struck ground obstacles, including three houses. Both airplanes came to

rest in a residential area about 2 miles northeast of the Greenwood Municipal Airport. The five occupants of the MU-2 were killed. The pilot of the PA-32 was killed, and the other two occupants were seriously injured. Pieces of the MU-2's left horizontal stabilizer and elevator were recovered during the search of a cornfield west of where the major portion of the MU-2's tail section came to rest. The fuselage came to rest inverted about 1/4 mile east of the tail, while the PA-32 came to rest upright in the back yard of a local resident about 1 mile east of the MU-2. (See figure 1).

The collision occurred in daylight VMC at 39 degrees, 39 minutes and 22 seconds north latitude and 86 degrees, 03 minutes and 41 seconds west longitude.

## 1.2 Injuries to Persons

<u>Injuries</u>	<u>Crew</u>	<u>Passengers</u>	<u>Others</u>	<u>Total</u>
Fatal	2*	4	0	6
Serious	1	1	0	2
Minor/None	<u>0</u>	<u>0</u>	<u>=</u>	<u>0</u>
Total	3	5	0	8

\*Includes the pilots of both airplanes.

## 1.3 Damage to Aircraft

The MU-2 was destroyed by the collision, ground impact, and the postcrash fire; its value was estimated at \$750,000. The PA-32 was destroyed by the postcrash fire shortly after ground impact. Its value was estimated at \$85,000.

## 1.4 Other Damage

Debris from the two airplanes was scattered over a rectangular residential area approximately 1/2 by 1 mile in Southern Marion County, Indiana. Three houses located on Southern Lakes Drive were damaged when the fuselage of the MU-2 came to rest in their back yards and caught fire. The PA-32 struck the roofs of two houses on Dornock Drive causing minor damage. The airplane touched down in the back yard of one of those houses, and its left wing struck and destroyed a children's playhouse. The impact separated the outboard 4 feet of the left wing

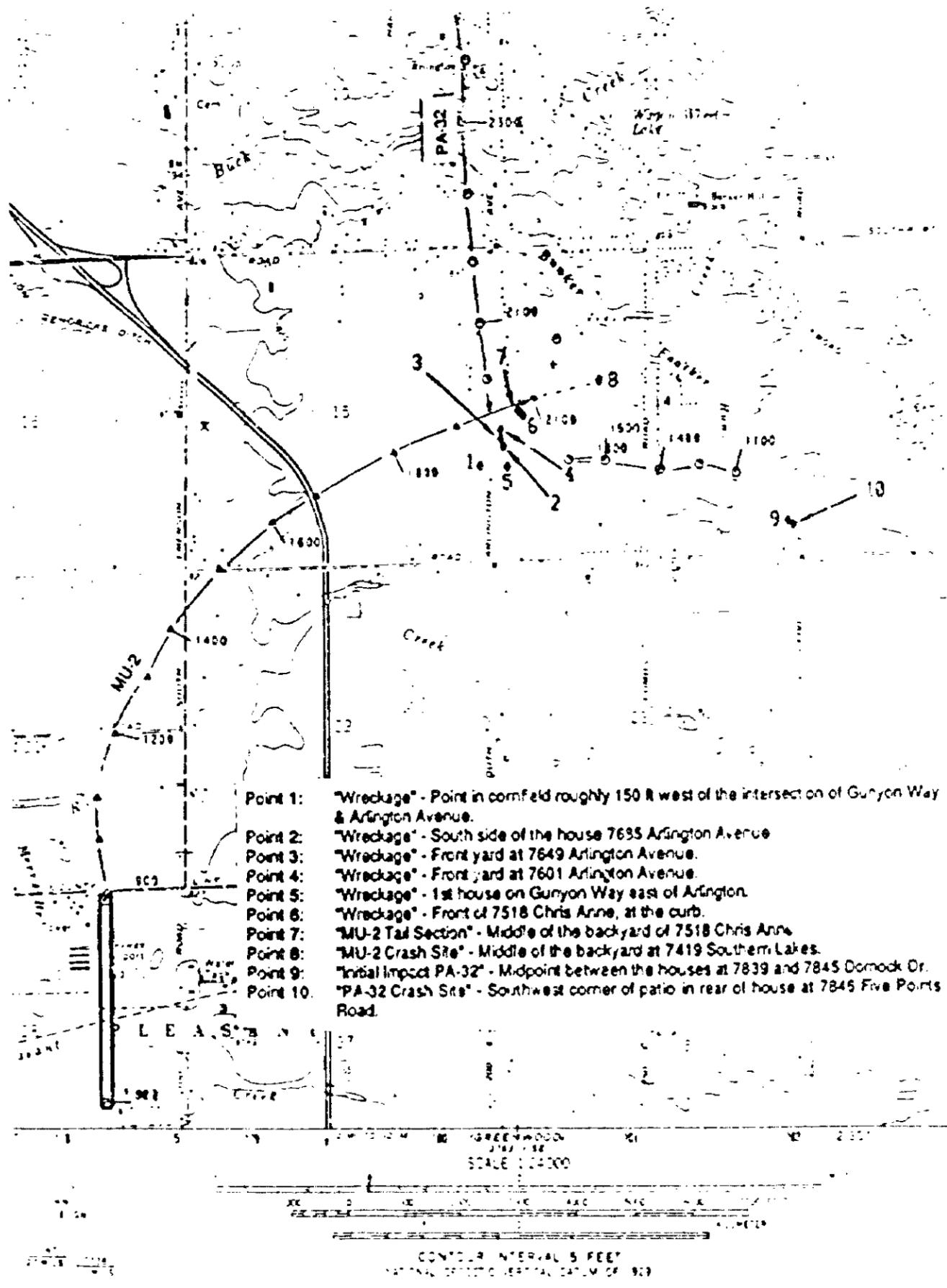


Figure 1.--Wreckage plot.

from the airplane. The airplane then slid through the fence at the rear of the yard and into the back yard of another house, coming to rest next to the rear of the house. A postcrash fire consumed the airplane and a major portion of the house. The fire caused minor damage to an adjoining house.

The estimated property damage to houses and other structures was \$280,000.

## **1.5 Personnel Information**

### **1.5.1 The Pilot of the PA-32**

The 54-year-old pilot of the PA-32 was qualified in accordance with applicable regulations. He held a private pilot certificate for single-engine airplanes and an instrument rating. He began flying general aviation airplanes in 1969 and had logged in excess of 1,200 total hours, approximately 150 hours of which were in the PA-32. The pilot's training and certification records revealed that he had completed a biennial flight review on May 12, 1991, and that he had no history of flight safety violations or aircraft accidents. The pilot was familiar with the Indianapolis area. His activities in the days before the accident were routine, including his eating and resting habits.

The pilot held a valid third class medical certificate dated October 18, 1991, with the limitation "must wear corrective lenses while flying." His vision was shown on the form as: for distant vision, the right eye as 20/70 corrected to 20/30; the left eye as 20/30 corrected to 20/20; and the combined vision as 20/40 corrected to 20/20. For near vision, both eyes were listed as 20/100 with the right corrected to 20/20 and the left to 20/30. The combined vision was listed as 20/100 corrected to 20/20. He could wear either glasses or contact lenses. It could not be determined if the pilot was wearing his glasses or contact lenses at the time of the collision. According to his wife, his health had not changed in the past year. He drank alcohol socially and did not take prescription medicine.

The pilot was involved in the ownership of Control Systems Engineering, the company that owned the PA-32. The company had recently purchased property approximately 3 miles from the Greenwood Municipal Airport. Part of the purpose of the flight was to take aerial photographs of this property with one passenger using a video camera and the other passenger using a still camera. The cameras were destroyed in the impact and postcrash fire.

Operation of the PA-32 does not require a second pilot; however, a qualified pilot was seated in the right front seat and had access to the flight controls. He was qualified in accordance with applicable regulations, and he held a private pilot certificate for single-engine airplanes and an instrument rating. He was employed as an engineer by Control Systems Engineering. A postaccident interview with his wife revealed that he was due to take a biennial flight check. Part of the purpose of the flight was to prepare for this test. As a result of the collision, the pilot-in-command was incapacitated, and the pilot-passenger assumed control of the PA-32 and made an emergency landing.

### 1.5.2 The Pilot of the MU-2

The 68-year-old pilot of the MU-2 was properly certificated and was adequately trained and experienced to conduct the flight. He had been employed by Solar Sources, Inc., Greenwood, Indiana, a mining corporation that owned the MU-2 and a Piper Aztec as corporate airplanes. He had been its principal pilot for about 8 years.

The pilot was qualified in accordance with applicable regulations. He held a commercial pilot certificate with an instrument rating for single and multiengine airplanes. Additionally, he was certificated as an instrument flight instructor for both single and multiengine airplanes. He learned to fly in the U.S. Army-Air Force and had converted his military licenses to civilian licenses. At the time of the accident, he had logged more than 19,000 hours of pilot time, of which about 9,000 hours were in the MU-2. The pilot's certification records revealed that he had completed a biennial flight review on July 10, 1992, and that he had been involved in two incidents: in 1980, an in-flight loss of all electrical power but successful airplane landing; and in 1984, a wheels-up landing.

The pilot held a valid second class medical certificate dated October 11, 1991. His vision shown on the medical application form was: for distant vision; the right eye as 20/20 corrected to 20/15, and the left eye as 20/30 corrected to 20/15; for near vision; both eyes as 20/60 corrected to 20/25. He wore glasses for an astigmatism and was seen wearing glasses at the Greenwood Flight Center before he departed on the accident flight. According to his wife, the pilot's health was excellent and had not changed in the past year. He exercised, did not smoke, drank alcohol only occasionally, and he did not take prescription medicine.

### 1.5.3 Air Traffic Controller

Radar Controller.--The controller who was working the DRE/Satellite position at the Indianapolis International Airport at the time of the accident was qualified to assume the responsibilities of his position. Examination of the controller training records did not reveal any deficiencies.

Supervisor.--The area supervisor was a full performance level controller, qualified in his assigned position.

Interviews with the controllers did not reveal any deficiencies in their knowledge of relevant air traffic control (ATC) procedures or policies.

### 1.6 Aircraft Information

The Piper PA-32-301, N82419, was owned by Control Systems Engineering Inc. It was leased to and operated by R.A.F. Limited Flight School, Eagle Creek Airport, Indianapolis, Indiana. The airplane was certificated, equipped, and maintained in accordance with Federal Aviation Administration (FAA) regulations. A review of the airplane's maintenance records that were available revealed no discrepancies relevant to the circumstances of the accident flight. FAA records indicate that the airplane was issued a standard certificate of airworthiness on June 20, 1980.

At the time of the accident, the airplane had accumulated 2,416 hours of flight time. The engine, a Lycoming IO-540-K1G5, was rebuilt by an authorized repair station in June 1989, and had accumulated 976 hours since overhaul. The airplane was inspected in accordance with Federal Aviation Regulation (FAR) 91.409(b). The most recent inspection was an annual one completed on July 29, 1992. The airplane had flown 53 hours since that inspection. The PA-32 was painted gray with red and black trim markings and had an anti-collision light installed on the vertical stabilizer and strobe lights installed on the wing tips. It could not be determined whether the strobe lights were on at the time of the collision.

The MU-2B-60 (MU-2), N74FB, was owned and operated by Solar Sources, Inc., of Indianapolis, Indiana. The airplane was manufactured in August of 1980, and was issued a standard certificate of airworthiness on January 23, 1980, according to FAA records. It was powered by two Garrett TPE 331-10-511M

engines. A review of the airplane's maintenance records revealed no outstanding discrepancies or deferred maintenance.

At the time of the accident, the airframe had accumulated 4,098 hours. Both of the engines were factory overhauled by the manufacturer in November 1990, and had accumulated 602 hours since that time. The airplane was inspected in accordance with an approved inspection program as required by 14 CFR 91.409(f)(4). The most recent inspection was a 150-hour check completed on May 29, 1992. The airplane had flown 76 hours since that inspection. The MU-2 was painted white with blue and silver trim markings and had strobe lights installed on both wing tip fuel tanks and the vertical stabilizer. During interviews with Safety Board investigators, the backup MU-2 pilot stated that it was the practice of the MU-2 pilot to use the strobe lights. However, the cockpit was so badly destroyed that switch position was not determined, and filament analysis on the strobe light bulbs was not performed.

#### 1.7 Meteorological Information

At the time of the accident, the weather conditions in the Indianapolis area were high scattered clouds and excellent visibility. The weather observations at the Indianapolis International Airport, about 13 miles west-northwest of the accident location, were:

Time--1450; Surface Aviation: 4,500 feet scattered; 25,000 feet scattered; visibility--15 miles; temperature--70 degrees F, dew point--49 degrees F; wind--020 degrees at 10 knots; altimeter--30.29 inches Hg.

Time--1504; Special: 4,500 feet scattered; visibility--15 miles; temperature--68 degrees F, dew point--48 degrees F; wind--050 degrees at 5 knots; altimeter--30.28 inches Hg.

Time--1550; Surface Aviation: 4,500 feet scattered, visibility--15 miles; temperature--71 degrees F, dew point--47 degrees F; wind--340 degrees at 4 knots; altimeter--30.28 inches Hg.

The position of the sun relative to the accident site at the time of the accident was 230 degrees (true) in azimuth and 43 degrees in elevation.

## **1.8 Aids to Navigation**

Not applicable.

## **1.9 Communications**

Interviews with the controllers assigned to the Indianapolis Departure East/Satellite (DRE/Satellite) did not reveal any communications difficulties with either airplane.

The DRE/Satellite controller stated he was in communication with six to eight aircraft at the time of the accident. Based upon the number of aircraft on frequency and the coordination required for an associated restricted military airspace, the controller judged his workload to be moderate at the time of the accident.

## **1.10 Aerodrome Information**

Greenwood Municipal Airport is an uncontrolled airport approximately 12 miles southeast of Indianapolis International Airport, Indianapolis, Indiana. (See figure 2). The field elevation of the airport is 822 feet. The airport has one asphalt runway oriented on a north/south direction with runway headings of 180 degrees and 360 degrees. The runway is 3,462 feet long and 50 feet wide and has pilot-controlled low, medium, and high intensity runway lights. Runway 18 has a displaced threshold 465 feet south of its approach end. The airport is approximately 1.5 miles southeast of the Indianapolis ARSA.

The airport reported 42,400 aircraft operations for the year ending June 9, 1992. This number included operations for 7,208 air taxi aircraft, 24,168 general aviation locals (operations remaining in the local traffic pattern and to or from the airport and a practice area within a 20-mile radius of the airport), 10,600 general aviation itinerants (operations not classified as "local," including air carriers and air taxi aircraft), and 424 military aircraft. The airport, like many other U.S. airports without operating control towers, is equipped with one type of common traffic advisory frequency (CTAF) known as UNICOM, which operates on a frequency of 123.0 kHz.

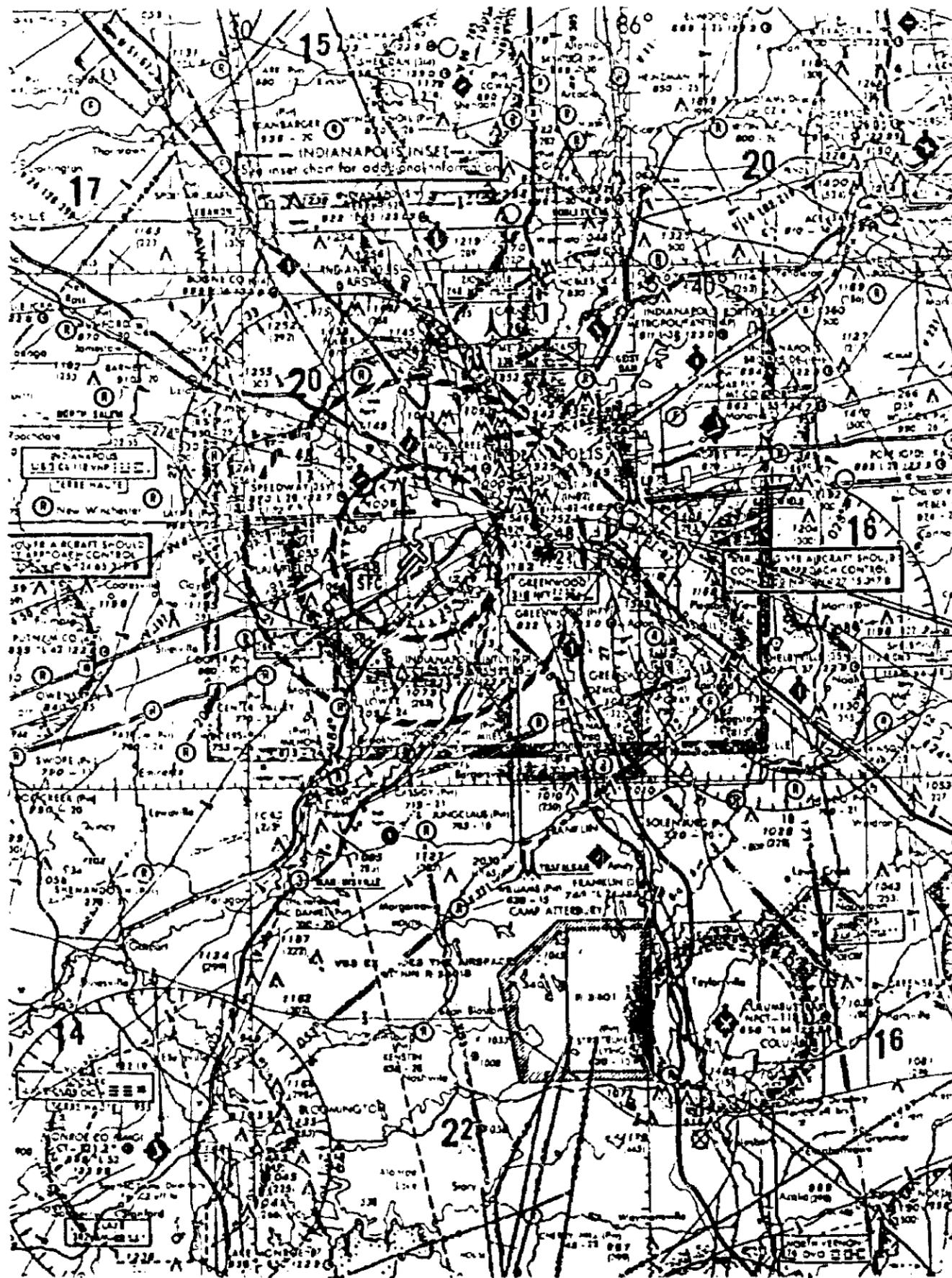


Figure 2.--Sectional chart of ARSA and Greenwood Airport.

The UNICOM is explained in the Airman's Information Manual (AIM) as a "nongovernmental air/ground radio communication station which may provide airport information at public use airports where no tower or Flight Service Station (FSS) exists. On pilot request, UNICOM stations may provide pilots with weather information, wind direction, the recommended runway or other necessary information. This and other CTAFs afford pilots a means to communicate their intentions and to obtain airport traffic information when operating to or from airports without operating control towers.

### **1.11 Flight Recorders**

Cockpit voice recorders (CVRs) or flight data recorders (FDRs) were neither installed nor required in either airplane.

### **1.12 Wreckage and Impact Information**

Wreckage and debris from the two airplanes were located at two main sites, approximately 4,200 feet apart, in a residential area of Franklin Township in Marion County, Indiana. One wreckage site contained the MU-2 fuselage, its wings, and engines. The empennage was found a few blocks east of the fuselage; the left horizontal stabilizer and elevator were found in a corn field east of the empennage. The other main wreckage site contained almost all of the wreckage of the PA-32.

#### **1.12.1 The MU-2**

After the collision, the MU-2 continued on a northeasterly heading and crashed inverted in the back yard of the house at 7419 Southern Lakes Drive. A postcrash fire consumed the airplane and caused property damage to three houses nearby.

The main portion of the empennage landed in the back yard of a house located about 2 blocks from the back yard of the house on Southern Lakes Drive where the MU-2 crashed. This piece of wreckage consisted of the empennage, vertical stabilizer with a portion of the rudder attached, the right horizontal stabilizer, and the right elevator.

The lower portion of the rudder, and the left horizontal stabilizer and elevator were found in a corn field about 150 feet west of the residential

neighborhood. Small pieces of metal from the inboard portion of the left horizontal stabilizer and lower portion of the rudder were found in the yards of houses. The left elevator balance weight was found in a parkway adjacent to a driveway of a house. There was evidence of a propeller strike on the balance weight, and the weight was spattered with oil. There were three propeller slashes in the upper skin of the left horizontal stabilizer. The left horizontal stabilizer was crushed rearward in an accordion manner, from the deicing boot to the rear spar, and the leading edge was displaced upward. There was a transfer of gray paint onto the leading edge deice boot.

The lower portion of the rudder near the lower hinge point, was twisted, torn, and covered with oil. The inboard section of the left elevator torque tube was crushed and had a semicircular depression. There were circular scratches and tears in the upper section of the vertical stabilizer and in the left side of the empennage forward of the horizontal stabilizer.

The MU-2, less the empennage, remained intact until the airplane struck the ground. The postcrash fire completely destroyed the cockpit, cabin and wings. Both engines were partially buried in the ground.

There were no recoverable cockpit instruments. The throttle quadrant was recovered from the cockpit wreckage. The power levers were full forward, and the condition levers were in their "takeoff-land" position. The landing gear, control handle, and flaps were in the "up" position. The flap jackscrews and switch were also in the "up" position.

Both engines showed evidence of producing power at ground impact. Both propellers had multiple bends and nicks. The first stage impellers of both engines showed rotational damage and bending opposite the direction of rotation. The left engine had metal spray on its igniter. The right engine had soil on its igniter.

### **1.12.2 The Piper PA-32**

After the collision, the PA-32 continued a gradual descent in an easterly direction for almost 1 mile before it struck and caused minor damage to the roofs of two houses. It came to rest in the back yard of a third house. A postcrash fire consumed the airplane and a major portion of the house and caused minor damage to an adjoining house.

Some small pieces of debris from the airplane were found near the probable collision location. A belly stiffener from the right side of the fuselage immediately aft of the firewall was found next to the south side of a house in the neighborhood. The stiffener had black rubber transfer marks on it. Pieces of engine cowling were found in a vacant lot.

The propeller spinner was crushed and twisted around the propeller dome. There were blue paint transfers on the spinner, which was covered with oil and dirt. One propeller blade had separated in its hub, and had oil streaks on the blade root. All three propeller blades were missing sections 4 to 6 inches in length from their tips, and all three propeller blades had multiple nicks and bends. There were blue paint transfers on the blades and blue paint chips inside the propeller spinner.

The cockpit, cabin, right wing and inboard portion of the left wing were destroyed by fire. There was no recoverable information or data from the cockpit instruments because they were also consumed in the fire. The flaps were verified to have been up by the position of the flap handle and the actuator bellcrank. The empennage with the stabilator, vertical stabilizer, and rudder did not burn but were damaged during the ground impact sequence.

### **1.13 Medical and Pathological Information**

The postmortem examinations of the pilots of both airplanes were performed by the Indiana University School of Medicine, Department of Pathology, Forensic Division. The examinations found no preexisting conditions that contributed to the accident. The carboxyhemoglobin level of the PA-32 pilot was measured at 5.2 percent of the total hemoglobin, and the cause of death of the pilot of the PA-32 was attributed to smoke inhalation and burns. The pilot and passengers of the MU-2 died of multiple traumatic injuries sustained at ground impact following the collision. The autopsy of the pilot of the PA-32 revealed neither what incapacitated him following the collision nor why he did not exit the burning airplane following the ground impact sequence.

Toxicological tests were completed by the American Institute of Toxicology, Indianapolis, Indiana, on blood and urine samples obtained from the pilot of the PA-32. Tests on both samples were negative on a large drug screen, including ethanol and major drugs of abuse.

Toxicological testing was completed by the FAA's Civil Aeromedical Institute on liver and kidney samples obtained posthumously from the pilot of the MU-2. Tests on kidney fluid indicated no ethanol, and tests on liver fluid were negative for a drug screen that included major drugs of abuse.

The Safety Board requested that the FAA provide blood and urine samples from all FAA personnel who had handled either airplane involved in the collision. The air traffic controllers declined to provide specimens for such testing. The manager of the Great Lakes Air Traffic Control Division decided separately that urine samples were not applicable to the investigation, under the FAA's postaccident drug testing guidelines. Based on his determination that there were no performance problems involving air traffic controllers at the time of the collision, urine samples were not obtained from them.

#### **1.14 Fire**

Although witnesses indicated that the PA-32 was trailing smoke or some kind of fluid after the collision, the postcrash fire may have destroyed any evidence of an in-flight fire. The investigation did not find any evidence of an in-flight fire on either airplane.

The Franklin Township Fire Department, along with units from Perry Township, Beech Grove, and Warren Township, responded to the postcrash fires at both wreckage sites. All units were notified simultaneously at 1459. The first units arrived about 1502 at the MU-2 site and about 1505 at the PA-32 site. The fires were considered under control at 1535 and 1545, respectively.

#### **1.15 Survival Aspects**

The passenger-pilot in the right front seat and the passenger in the rear cabin of the PA-32 survived the collision and exited the airplane after it came to rest in the back yard of a house. The pilot in the left seat was incapacitated during the collision and did not exit the airplane before the postcrash fire enveloped the airplane and house.

Although the cockpit and cabin of the MU-2 were not compromised during the collision, the airplane was uncontrollable. The pilot and passengers did not survive the impact with the ground.

## 1.16 Tests and Research

The Safety Board examined radar returns recorded by the Automated Radar Terminal System (ARTS IIIA) of the Indianapolis Terminal Radar Approach Control (TRACON). The Safety Board also examined the conspicuity of both airplanes and studied factors that would have affected the ability of each airplane pilot to see the other as viewed from each cockpit. A visibility study was conducted to determine the locations and sizes of the airplanes as they would have appeared in their respective binocular fields of vision, as defined by a single fixed-eye position.

### 1.16.1 Indianapolis TRACON

ARTS IIIA radar data recorded for the period from 1431 through 1458 on September 11, 1992, were obtained from the Indianapolis TRACON for evaluation by the Safety Board. Using the recorded radar data (see figure 3), ground track plots were made on an Indianapolis sectional chart to illustrate the track line histories of the airplanes.

Recorded radar data indicated that at 1444:51 an airplane associated with a "1200" beacon code, assumed to be the PA-32, was directly north of Terry Airport at an altitude of 1600 feet. At 1445:33, the radar target, assumed to be the PA-32, switched to a beacon code of "0301" and continued to track to the south. At 1456:04, a "1200" beacon code target, assumed to be the MU-2, was observed approximately over Greenwood Municipal Airport at 900 feet heading northeast. At 1456:08, the radar data indicated that the PA-32 switched beacon codes to "1200" and continued to track to the south at an altitude of 2,500 feet. At 1456:51, recorded radar data indicated a beacon target report of "4564," assumed to be the MU-2, at 1,900 feet northeast of the airport. At 1456:55.47, one "4564" (last recorded radar return) and one "1200" beacon target report were recorded in close proximity to each other at an altitude of 2,100 feet, 11.4 nautical miles southeast of Indianapolis International Airport, and 2 miles northeast of the Greenwood Airport.

Radar Only (RO)<sup>4</sup> data indicated one return near the two airplanes at 1457:00.19. A "1200" beacon target report, assumed to be the PA-32, continued to descend on a southeasterly track until reaching 1,100 feet at 1457:19.

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<sup>4</sup>Target reports based on ATC radar primary returns rather than on mode A transponder beacon returns.

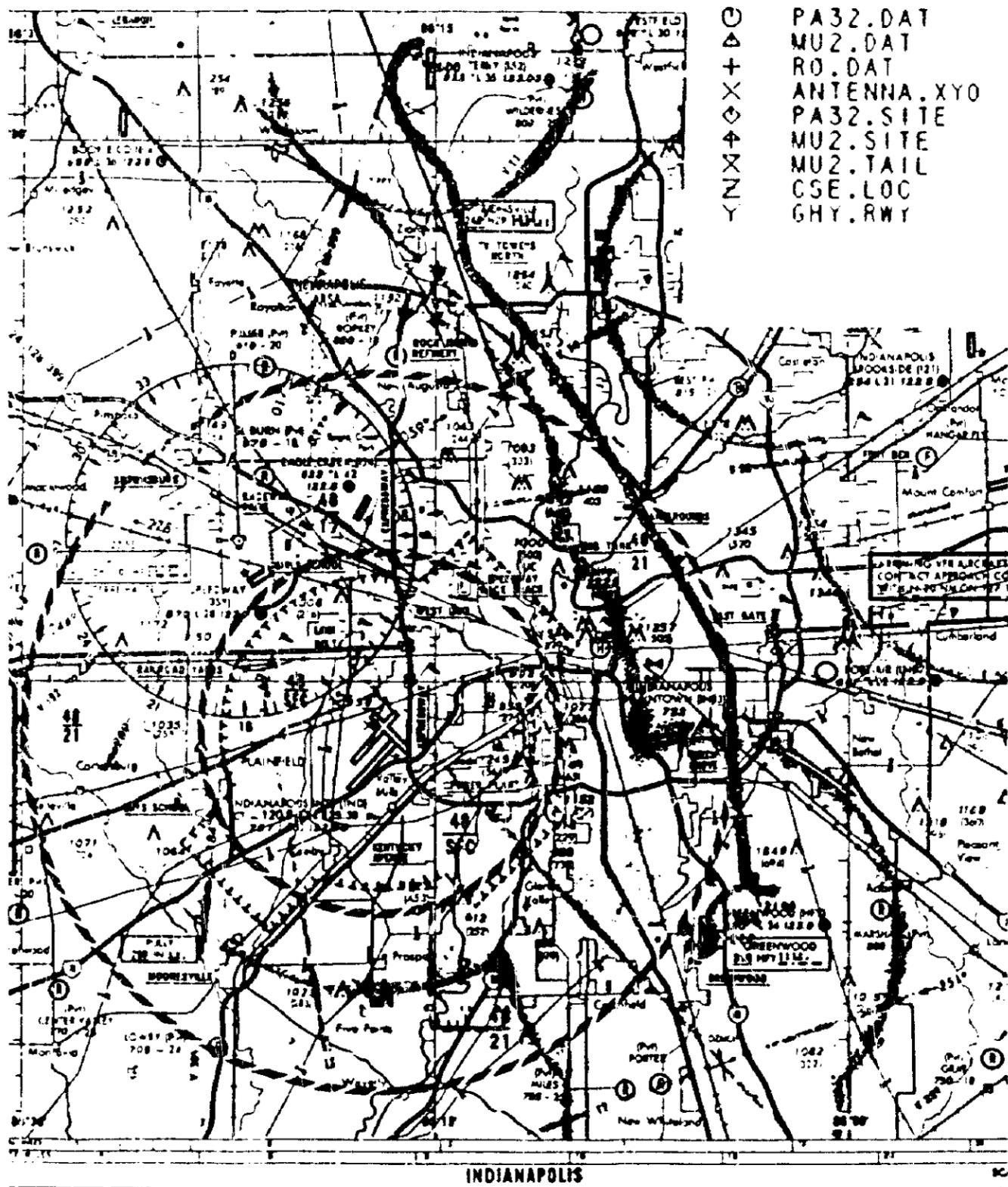


Figure 3.--Recorded radar ground track plots.

The Airport Surveillance Radar (ASR) magnetic tape data from the Indianapolis sensor were processed at the Safety Board's facilities. The beacon target reports for transponder codes 0301, 4564, and 1200, assumed to be associated with the PA-32 and N74FB between 1431:00 and 1458:00, were identified. Also obtained were the positions of the MU-2's fuselage and tail section, the PA-32, and the Control Systems Engineering building. The coordinates for runway 18/36 at Greenwood were supplied by the FAA. Indianapolis Terminal Control Area (TCA) location and dimensions were obtained from the St. Louis Aeronautical Sectional Chart. These data, along with the recorded radar data between 1431:00 and 1458:00, were scaled in nautical miles and plotted using the location of the Indianapolis sensor as the origin.

Plots of the data were overlaid onto the St. Louis Aeronautical Sectional chart (1:250000) and the U.S. Geological Survey Beech Grove, Indiana Quadrangle map (1:100000). Dialogue from the ATC transcript was correlated to the recorded radar data and position plot, along with an overlay of the ATC transmissions between the controllers and both airplanes.

### **1.16.2 Airplane Performance Calculations**

The Safety Board examined the recorded radar data to determine the positions, altitudes, velocities, and flightpaths of both airplanes. The radar data indicated that the minimum separation occurred about 1456:53, the estimated time of the collision.

The last radar return recorded for the PA-32 before the collision was considered spurious and was not used. As a result, it was necessary to extrapolate the PA-32 radar data to approximate the collision point.

The smoothed and interpolated radar ground track coordinates were used as input data to a National Aeronautics and Space Administration (NASA) computer program entitled "MANAT." This program used position and time data to calculate performance parameters, such as air speed, ground speed, roll angle, pitch angle and vertical acceleration. The program also used wind and temperature data, as well as airplane-specific information. The abrupt maneuver made by the PA-32 just prior to the collision, as reported by the surviving occupants, would not have been detected by the radar data due to its sampling rate of 1/4.7 seconds.

The program revealed that during the last 11 seconds of recorded data prior to the collision, the average ground speed of the MU-2 was 168 knots, the average indicated air speed was 163 knots, the average magnetic heading was 066 degrees, and the average vertical velocity was +1,596 feet per minute. The recorded data for the PA-32 during this period indicated that during the same time, its average ground speed was 127 knots, indicated air speed was 118 knots, magnetic heading was 173.5 degrees, and average vertical velocity was -390 feet per minute. Figure 4 shows the radar track time histories of the airplanes as recorded by the Indianapolis ARTS IIIA.

### 1.16.3 Cockpit Visibility Study

A cockpit visibility study was conducted to determine the probable locations and sizes of the airplanes as they would have appeared in the windscreens of each airplane. To accomplish this, the viewing angle for both airplanes was calculated and plotted for their respective pilots' fields of vision. The calculations were based on flightpath, attitude time histories, and length and wingspan of the airplanes.

The raw ground track information presented in the radar study and extrapolated coordinates were used to calculate performance and probable locations of the airplanes. This task involved defining the limits of the respective fields of vision based on a single fixed eye position and determining if they had sufficient time to react and therefore to "see and avoid."

A binocular camera was used to photograph cockpits of two similar airplanes. The camera uses a continuous strip of film to produce a panoramic view of the window configuration. Horizontal and vertical grid lines in 5-degree increments are superimposed on the photographs. The resulting photographs show the outline of the cockpit windows as seen by a pilot rotating his head from side to side. Monocular obstructions within the window, such as windshield or door posts, are also defined by the photographs.<sup>5</sup>

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<sup>5</sup>Areas where objects can be seen with only one eye.

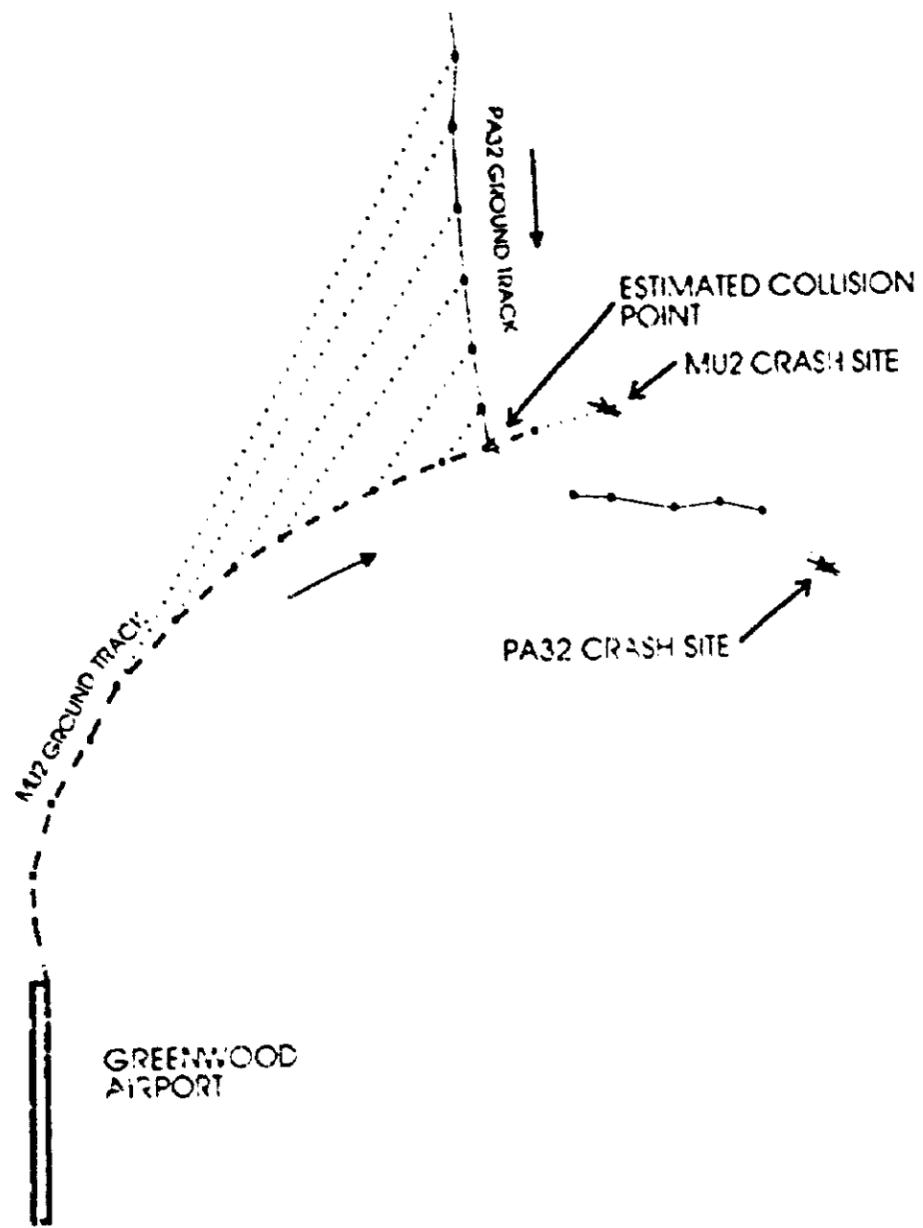


Figure 4.--ATC radar track time histories.

The binocular photographs were taken with the camera placed in the pilot's seat at the design eye reference point (DERP)<sup>6</sup> with the airplane on level ground. The view from the right front seat of the PA-32 was created by reversing the photographic image. The pilots involved in the accident were all of average height, so the use of the design eye reference point should have provided an appropriate approximation. The pilot of the PA-32 was 5 feet and 9 1/2 inches tall; the pilot-passenger of the PA-32 was 5 feet and 8 inches tall; and the pilot of the MU-2 was 5 feet and 11 inches tall.

The position time histories of the airplanes were superimposed on the photographs of the full field of vision for the pilots of both airplanes and the copilot's seat of the PA-32. This was accomplished by plotting the azimuth and elevation angles computed for the center of the target airplane on the respective crewmember's field of vision and, in the case of the PA-32, the passenger/copilot occupying the right cockpit seat. The positions of the target airplanes, as seen from the cockpit, were displaced as the airplanes' pitch and roll angles changed.

Based on the radar data, the collision was estimated to have occurred at 1456:53. Research has shown that, as a minimum, targets should subtend 0.2 degrees of arc to ensure accurate recognition<sup>7</sup> (see section 1.17.2 of this report). FAA Advisory Circular (AC) 90-48C, entitled Pilot's Role in Collision Avoidance, utilized military data to document that the minimum time necessary to recognize a potential in-flight target and to successfully execute an evasive maneuver is 12.5 seconds. At 12.5 seconds prior to the collision, the time was 1456:41. Therefore, the figures were constructed to display the viewing angle time histories from 1456:28 to 1456:41 (13 seconds) for the PA-32 and from 1456:33 to 1456:41 (8 seconds) for the MU-2.

The cockpit visibility study revealed that:

The PA-32 would have appeared<sup>d</sup> below the horizontal zero eye reference plane, in the lower left corner of the MU-2's windshield, clear of all obstructions from 1456:33 (20 seconds before the collision) to 1456:37. In the following 4 seconds, it could have

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<sup>6</sup>The design eye reference point is a single point established in accordance with provisions of Civil Aeronautics Manual (CAM) 4b.351-3, "Minimum Area of Visibility in the Flight Crew Compartment," 1955, from which the central viewing axis may be located.

<sup>7</sup>Morgan, C., Cook, J., Chapanis, A., and Lund, M., "Human Engineering Guide to Equipment Design." McGraw-Hill, New York, 1963.